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AgriLIFE EXTENSION
Texas A&M System

Calibrating Pesticide Application Ground Equipment

Bryan Shaw
Assistant Professor and Extension Agricultural Engineering Specialist, The Texas A&M University System.

Calibrating Pesticide Application Ground Equipment

Precise application of a specific rate of pesticide is important in efficient, economical pest control. Application equipment should be carefully and accurately calibrated. Equipment calibration can be achieved by following the suggested methods outlined in this guide.

Application Program Checklist

- Maintain a complete record of the application.
- Inform those working with the pesticide and others in the area of the necessary precautions in handling the chemical.
- Begin with clean equipment. Residues in the spray rig can cause serious problems. To clean the rig, use either a strong household detergent or a commercial decontaminate formulation. Most contain a combination of soda ash, detergent and alkaline chlorine. Rinse thoroughly with clean water. Remove nozzles to clean screens and tips. Apply rinse water to a field per label requirements or dispose of rinse water as hazardous waste. Clean and lubricate the pump. *Equipment used to apply certain pesticides should not be used to apply others. Do not use equipment to apply 2,4-D, MCPA, 2,4-DP, MCPP, and 2,4-DB for any other purpose because of difficulty in removing all traces of the pesticide.*
- Check all hoses. Hoses in good condition save time and eliminate possible spray mixture losses.
- Use screens upstream of the pump and each nozzle. Frequently check screens to avoid clogged nozzles.
- Use recommended nozzle types and attach nozzles firmly, using the correct height and angle to ensure proper application.
- Calibrate the sprayer and visually inspect the spray pattern from each nozzle to ensure that the nozzle is producing the proper spray distribution (use of a spray table will give more accurate indication of nozzle pattern). Replace any nozzle that varies more than 10 percent from the average flow rate, shows visual signs of wear or damage, or does not produce the proper spray distribution pattern. For application of some chemicals (such as certain potent sulfonyl urea herbicides), nozzles should be replaced if they deviate more than 5 percent from the average flow rate.
- Nozzle pressure should follow nozzle manufacturer's recommendation for each application type. Operating near the lower recommended pressure will produce larger droplets and minimize drift potential. Recommended nozzle pressure ranges from 10 to 60 pounds per square inch (PSI) for weed control. For insect control, pressure between 50 and 60 PSI typically is recommended. Disease control typically requires that a pressure of 100 PSI be maintained. Select nozzles that will deliver the calculated volume at the recommended pressure. If the sprayer is already equipped and the nozzles will not deliver the gallons per acre (GPA) in the desired time, change driving speed, gallons per acre applied or nozzle size to obtain desired nozzle pressure.

Calibration of Ground Sprayers

Method I

Step 1: Fill the sprayer tank with water to a predetermined level.

Step 2: Drive in a straight line for 660 feet, operating at the same pressure and tractor speed planned for field use. Record the tractor throttle and gear settings.

Step 3: Stop spraying at the 660-foot mark and measure the gallons of water needed to refill the tank to the predetermined level.

Step 4: Measure the width of actual area sprayed. For band applications, this equals the sum of the width of all bands.

Step 5: Calculate as follows.

$$\frac{\textbf{gallons used x 66}}{\textbf{width of sprayed area in feet}} = \textbf{gallons per acre}$$

Example: Seven gallons of water are required to refill the tank to the predetermined level for a boom sprayer (14 feet wide) after spraying a 660-foot-long swath.

$$\frac{7 \text{ gallons} \times 66}{14 \text{ feet}} = 33 \text{ gallons per acre}$$

Step 6: After calibrating the sprayer, add the correct amount of pesticide to the sprayer tank in the correct amount of carrier for the area to be sprayed. Tables 4-9 provide forms to assist with mixing calculations. Recalibrate the sprayer every 10 hours of operation or anytime there is a change in the pesticide formulation. Recalibrate more often when using wettable powders because they cause wear of pumps and nozzles made of soft metals.

Method II (Refer to Tables 1-3 for calibration forms.)

Step 1: Begin calibration with the sprayer and other attachments (planters, applicators, etc.) mounted on the tractor.

Step 2: In the field, with all attachments in operation, determine the desired traveling speed. For tractors with accurate speed sensors, skip to Step 5. Speed indicators that do not directly measure ground speed may indicate speed with as much as 30 percent error from variation in tire slip, tire size, etc. If in doubt, perform Steps 3 and 4.

Step 3: Measure and mark off a course; a longer course gives more accurate speed determination. A course 300 feet long is adequate. Measure in seconds how long it takes to travel the distance. Mark the throttle and gear setting. *A tractor travels slower in a soft field than on hard ground under the same settings.*

Step 4: Substitute the number of seconds to travel the course and the length of the course in the following formula to determine speed in miles per hour (MPH).

$$\frac{\textbf{MPH}}{\textbf{seconds traveled} \times 88} = \textbf{feet traveled} \times 60$$

However, if the desired speed is selected, the seconds to travel the course can be determined as follows.

$$\textbf{seconds traveled} = \frac{\textbf{feet traveled} \times 60}{\textbf{MPH} \times 88}$$

Example: It requires 51 seconds to cross a course 300 feet long. The speed is calculated as follows.

$$\frac{300 \times 60}{51 \times 88} = 4 \text{ MPH}$$

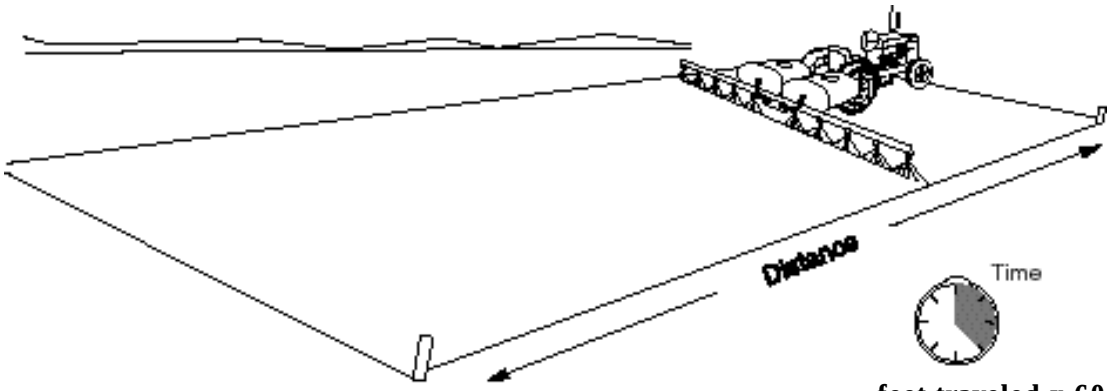
Step 5: Determine spray delivery from each nozzle in gallons per minute (GPM) for the desired speed, effective spray width, and gallons per acre (GPA). Effective spray width (measured in inches) is determined by the following:

- nozzle spacing for boom spraying,
- band width for band spraying,
- spray swath for broadcast boomless spraying, and
- width of band divided by number of nozzles for multi-nozzle band spraying.

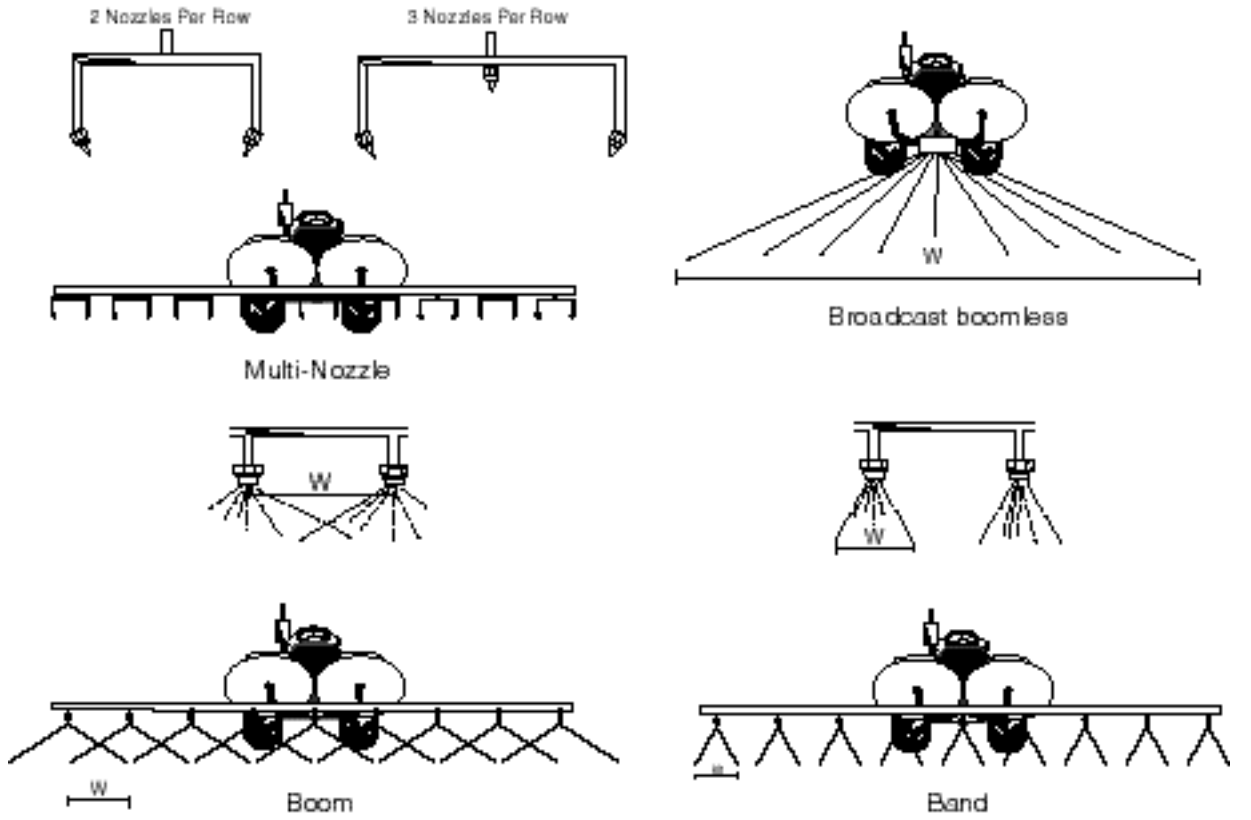
Calculate the nozzle delivery rate with the following formula.

$$\textbf{GPM per nozzle} = \frac{\textbf{GPA} \times \textbf{MPH} \times \textbf{W}}{\textbf{5940 (constant)}}$$

GPA = gallons per acre on the area treated
W = effective spray width in inches



$$\textbf{MPH} = \frac{\textbf{feet traveled} \times 60}{\textbf{seconds traveled} \times 88}$$

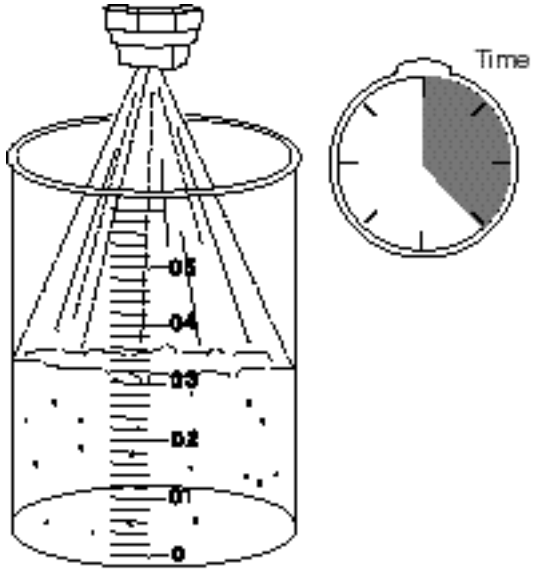


Step 6: With the tractor out of gear and engine running at the selected throttle setting, adjust the pressure regulator so that each nozzle delivers the calculated flow rate. The flow rate can be measured with a tip tester that indicates flow rate in gallons per minute or by measuring the time required to collect 1 quart from one nozzle.

Step 7: The number of seconds to collect a quart of spray mixture, or 32 fluid ounces, is determined by the following formula. Adjust the height and direction of nozzles to give the desired spray pattern overlap or band width as recommended by the nozzle manufacturer.

$$\textbf{seconds/qt./nozzle} = \frac{\textbf{15}}{\textbf{GPM per nozzle}}$$

Step 8: Recalibrate if speed or pressure is changed. Nozzles wear and sprayers should be recalibrated after every 10 hours of operation or anytime there is a change in the formulation of pesticide used.



Step 9: After calibrating the sprayer, add the correct amount of pesticide to the sprayer tank in the correct amount of carrier for the area to be sprayed. Tables 4-9 provide forms to assist with mixing calculations.

Examples using GPM per nozzle:

$$GPM\ per\ nozzle = \frac{GPA \times MPH \times W}{5940\ (constant)}$$

and

$$seconds/qt./nozzle = \frac{15\ (constant)}{GPM\ per\ nozzle}$$

1. *Boom spraying, broadcast.* Spray 30 GPA at 5 MPH with a 20-inch nozzle spacing on the boom. Select an 80-degree or 90-degree flat spray nozzle to deliver 0.51 GPM at suggested PSI. Adjust the pressure regulator to deliver 0.38 GPM per nozzle or to deliver 1 quart in approximately 30 seconds.

   a. $0.51\ GPM\ per\ nozzle = \frac{30 \times 5 \times 20}{5940}$

   b. $29.4\ seconds/qt./nozzle = \frac{15}{0.51}$

2. *Band spraying with one nozzle.* GPA is the amount applied to the area actually treated. If a 40 GPA rate is applied at 4 MPH on a 14-inch band, these numbers would be used accordingly. Select an 80-degree even spray nozzle to deliver 0.38 GPM at suggested PSI.

   a. $0.38\ GPM\ per\ nozzle = \frac{40 \times 4 \times 14}{5940}$

   b. $40\ seconds/qt./nozzle = \frac{15}{.38}$

3. *Band spraying with two or more nozzles per band.* If two nozzles are used to spray the 40-gallon per acre rate on a 14-inch band, calibrate by using width (W) of 7 inches (14 inches ÷ 2) in formula previously given in Step 5. Collect the quart from one nozzle in the time calculated with the formula given in the previous examples.

4. *Boomless spraying, broadcast.* Spray 20 GPA at 4 MPH and cover a 40-foot swath (40 feet x 12 inches/foot). With the tractor out of gear and the engine running at the throttle setting selected, adjust the pressure regulator so that 6.5 gallons is sprayed in 1 minute from the nozzle assembly. Select a single assembly of nozzles to deliver 6.5 GPM at suggested PSI.

   $$6.5\ GPM\ per\ nozzle = \frac{20 \times 4 \times (40 \times 12)}{5940}$$

5. *Spraying at a broadcast rate above 40 GPA.* Spray 50 GPA at 4 MPH with nozzles spaced 20 inches apart on the boom. Select an 80-degree or 95-degree flat spray nozzle to deliver 0.67 GPM at suggested PSI.

   a. $0.67\ GPM\ per\ nozzle = \frac{50 \times 4 \times 20}{5940}$

   b. The time in seconds to catch 1 gallon from each nozzle may be determined by:

   $$89.6\ seconds/gal./nozzle = \frac{60\ (constant)}{.67\ GPM\ per\ nozzle}$$

With the tractor out of gear and the engine running at the selected throttle setting, adjust the pressure regulator so 1 gallon of spray mixture is sprayed by each nozzle in 90 seconds. Follow Steps 7 through 9 to complete calibration.

Table 1. Determine Speed of Application

Step	Example	Yours
1. Mark off and measure length of course (feet traveled).	300 feet	_____
2. Time the spray rig as it crosses the course. Use gear and throttle setting you plan to use during application. Record seconds traveled.	51 seconds	_____
3. Calculate Speed (MPH) = (#1 x 60) ÷ (#2 x 88) $\mathbf{MPH = \frac{feet\ traveled \times 60}{seconds\ traveled \times 88}}$	4 MPH	_____

Table 2. Determine Flow Rate Needed

Step	Example	Yours
1. Gallons per acre of spray solution to be applied (GPA)	30 GPA	_____
2. Application speed (Table 1, Step 3)	4 MPH	_____
3. Effective width (W) (Effective width: nozzle spacing for boom spraying, band width for banding, spray swath for broadcast boomless, width of band divided by number of nozzles for multi-nozzle banding)	20 inches	_____
4. Flow rate needed from each tip (GPM) = (#1 x #2 x #3) ÷ 5940 $GPM = \frac{GPA \times MPH \times W}{5940}$	0.4 GPM	_____

Table 3. Calibration

Step	Example	Yours
1. Flow rate needed from each tip (GPM) (Table 2, Step 4)	0.4 GPM	_____
2. Time required to collect 1 quart (32 ounces) (15 ÷ #1) $seconds/qt./nozzle = \frac{15}{GPM}$	37 seconds	_____
3. With tractor out of gear and engine running at the throttle setting selected, adjust pressure regulator to deliver flow rate as calculated above.		

Table 4. Calculating amount of pesticide to add to tank for liquid pesticide (given pints per 100 gal. recommended by label)

Step	Example	Yours
1. Gallons in tank (GAL)	200 GAL	_____
2. Pints per 100 gallons recommended by label (pt./100 gal. desired)	2 pints	_____
3. Pints pesticide needed per tank (#1 x #2 ÷ 100) $\frac{GAL \times pt./100\ gal.\ wanted}{100\ gal.}$ or $\frac{200 \times 2}{100}$ = 4 pints needed	4 pints	_____

Table 5. Calculating amount of pesticide to add to tank (given pints per acre recommended by label)

Step	Example	Yours
1. Gallons in tank (GAL)	300 GAL	
2. Pints per acre pesticide recommended by label (pt./acre desired)	2pt./acre	
3. Gallons spray per acre to be applied (gal./acre)	20 gal./acre	
4. Acres sprayed per tank (#1 ÷ #3) $\frac{\textbf{GAL}}{\textbf{gal./acre}}$ or $\frac{300}{20}$ = 15 acres/tank	15 acres/tank	
5. Pints pesticide needed per tank (#4 x #2) **pints needed = acres/tank x pt./acre** or 15 x 2 = 30 pints needed	30 pints needed (3 gal., 6 pints)	

Table 6. Calculating amount of pesticide to add to tank for wettable powders (given lbs. per acre recommended by label)

Step	Example	Yours
1. Gallons in tank (GAL)	300 GAL	
2. Pounds per acre recommended by label (lbs./acre desired)	2 lbs./acre	
3. Gallons spray per acre to be applied (gal./acre)	20 gal./acre	
4. Acres sprayed per tank (#1 ÷ #3) $\textbf{acres/tank} = \frac{\textbf{GAL}}{\textbf{gal./acre}}$ or 300/20 = 15 acres/tank	15 acres/tank	
5. Pounds needed (#4 x #2) **lbs. needed = acres/tank x lb./acre** or 15 x 2 = 30 lbs. needed	30 lbs. needed	

Table 7. Calculating amount of pesticide to add to tank for wettable powders (given lbs. per 100 gal. recommended by label)

Step	Example	Yours
1. Gallons in tank (GAL)	300 GAL	
2. Pounds per 100 gal. recommended by label (lb./100 gal. desired)	2 lbs./100 gal.	
3. Pounds needed (#1 x #2 ÷ 100) $\textbf{lbs. needed} = \frac{\textbf{GAL x lbs./100 gal.}}{\textbf{100 gal.}}$ or $\frac{300 \times 2}{100}$ = 6 lbs. needed	6 lbs. needed	

Table 8. Calculating amount of pesticide to add to tank for wettable powders (given percent active ingredient recommended by label)

Step	Example	Yours
1. Gallons in tank (GAL)	200 GAL	
2. Percent active ingredient recommended by label (% A.I. desired)	3.5 %	
3. Specific weight of carrier (water: 8.34 lbs./gal.)	8.34 lbs./gal.	
4. Percent active ingredient in formulation, from label (% A.I. form.)	80%	
5. Pounds needed (#1 x #2 x #3) ÷ #4 **$\frac{\text{GAL x \% A.I. wanted x lbs./gal.}}{\text{\% A.I. form.}}$ = lbs. needed** or $\frac{200 \times 3.5 \times 8.34}{80}$ = 73 lbs. needed	73 lbs. needed	

Table 9. Calculating amount of pesticide to add to tank for emulsifiable concentrate (given percent active ingredient recommended by label)

Step	Example	Yours
1. Gallons in tank (GAL)	100 GAL	
2. Percent active ingredient recommended by label (% A.I. wanted)	1%	
3. Specific weight of carrier (water: 8.34 lbs./gal)	8.34 lbs./gal.	
4. Pounds active ingredient per gallon in formulation, from label (lb. A.I./gal. form.)	2 lbs. A.I./gal.	
5. Gallons emulsifiable concentrate needed (#1 x #2 x #3) ÷ (#4 x 100) **gallons needed = $\frac{\text{GAL x \% A.I. wanted x lbs./gal.}}{\text{lbs. A.I./gal. form. x 100}}$** or $\frac{100 \times 1 \times 8.34}{2 \times 100}$ = 4.17 gal. needed	4.17 gal. needed	
6. Need 4 gallons plus (0.17 gal. x 128 ounces/gal. = 22 ounces)	22 ounces	4 gal.,

Common Conversions

- 1 acre = 43,560 square feet, 209 feet x 209 feet
- 1 section = 640 acres or 1 square mile
- 1 hectare = 2.471 acres
- 1 mile = 5,280 feet or 1,760 yards
- 1 pound = 453.6 grams or 16 ounces
- 1 gallon = 128 ounces, 3,785.4 milliliters, 16 cups, 4 quarts, 8.34 pounds or 256 tablespoons
- 1 quart = 0.946 liters, 2 pints or 32 ounces
- 1 pint = 16 ounces or 2 cups

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